

Land engineering and its role for sustainable agriculture in the agro-pastoral ecotone:

A case study of Yulin, Shaanxi Province, China

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Abstract: With global climate change, the agricultural light-temperature potential productivity in the agro-pastoral ecotone has increased. This offers a good opportunity to develop agriculture in the agro-pastoral ecotone. However, the agro-pastoral ecotone is also an ecologically fragile area in which land degradation challenges agricultural development. As population grows and the need for food increases, the land carrying capacity of the agro-pastoral ecotone becomes insufficient, and the human–land relationship is not harmonious. Such conditions have limited the agricultural and rural development in the ecotone. The paper demonstrates how land engineering may improve land quality and support agricultural development in the ecotone based on studies at a research station established in 2015 in Yulin, Shaanxi Province, China. The studies target three factors: soil improvement, crop selection, and field management. The results show that: (1) The highest yield of crops planted on improved land is close to or even higher than that achieved under previous crop growth conditions. For instance, the corn yields can exceed 25%. (2) The potatoes grown on the improved land yield the highest gross income, reaching 67,200 yuan/ha. By way of land engineering, input costs can be balanced in 3–5 years. (3) As a result of land engineering, some villages in Yulin City have realized sustainable agricultural and even rural development, and promotion of this model will support the sustainable development of agriculture in the agro-pastoral ecotone.

Keywords: agro-pastoral ecotone; land engineering; degraded land consolidation; human–land relationship; sustainability

1 Introduction

Global food security is one of the great challenges of our time, as we seek to accommodate not only a growing world population, but also a more affluent society that is more demand-

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ing in its requirements for a secure and consistent supply of safe and high-quality food. Efforts to introduce more technocratic solutions for global food security, for example, include the use of genetically modified organisms and the intensification of agricultural production to enhance grain production throughout the world. Recently, the importance of land engineering, which consolidates degraded land and improves soil conditions, has started to assume importance (Li *et al.*, 2018).

In China, the agro-pastoral ecotone widely exists in the north, northwest, and southwest parts of the country. These places have long been facing severe ecological problems such as land degradation and water shortages. Desertification, which is considered one of the most serious challenges in the agro-pastoral ecotone, covers an area of $72.5 \times 10^4 \text{ km}^2$ (Liu *et al.*, 2018a). Owing to global climate change, the gravitational center of China's grain production has moved northward, and the agricultural light-temperature potential productivity has increased in the agro-pastoral ecotone, which is expected to become one of the key granaries for North China (Liu *et al.*, 2009; Liu *et al.*, 2018b). However, the expanded grain production has aggravated the contradictions between natural resources, such as, land and water, and the local rural economy in the agro-pastoral ecotone.

To date many researchers have undertaken agricultural research in the agro-pastoral ecotone in areas such as the formation mechanism of the degraded land (Huang *et al.*, 2007), the status of degraded land (Liu and Gao, 2002), land use/cover change (LUCC) and its response (Zhao *et al.*, 2017), land carrying capacity and ecosystem services (Wang *et al.*, 1999; Jia *et al.*, 2014). Since 1999, the Grain for Green Project has been implemented in the agro-pastoral zone. Then, the Grazing Ban Policy was put into practice and this policy has played an important role in ensuring the ecological security of the region. Nevertheless, these kinds of policies have limited impact on local rural development. To improve agricultural production, the state has introduced relevant policies to adjust the agricultural production structure in the agro-pastoral zone, providing new ideas for agricultural and rural development in this area. These studies and policies have highlighted the status quo and constraints to agricultural and rural development in the agro-pastoral ecotone, and also provided scientific support for carrying out land engineering as a cooperative approach to improving local land conditions in the ecotone.

The concept of land engineering has become popular in recent years. Land engineering is a kind of comprehensive technology which includes investigation, evaluation, planning, design, development, remediation, and protection of land resources and its integrated application. It is an interdisciplinary subject combining land resources science with engineering technology (Liu, 2015). The implementation of land policy measures requires the adoption of specific technologies and methods, and land engineering is such a technology and method. Land engineering aims to promote the harmonious development of the human-land relationship and uses engineering methods to solve land problems. The goal of land engineering is to improve land quality and optimize land use structure by way of management, engineering, and other means to maximize land output benefits such as by converting unused land into usable land, and low-quality land into high-quality land (Han and Zhang, 2014). In essence, the imbalance between humans and land in the agro-pastoral ecotone is due to the mismatch between related elements, e.g. the light and temperature resources are not coordi-

nated with the water and soil resources. Land engineering takes the various elements of the land as the main objects, and through engineering measures supplements the insufficient elements or improves the interrelationships between the various elements, thereby regulating the water and soil relationship and promoting farmland ecological engineering and rural system engineering (Liu *et al.*, 2016). The ultimate purpose is to harmonize the human–land relationship and urban–rural relationship. So far, land engineering has already proved its role in gully land consolidation in the Loess Plateau (Li *et al.*, 2016; Liu and Li, 2017b), and in hillside ecological land improvement in the Taihang mountain region (Zhou *et al.*, 2018), and comprehensive improvement of “hollow” villages in agricultural areas (Chen *et al.*, 2010). Land engineering has gradually become a powerful way to breakdown regional resource constraints and promote agriculture and rural development.

How does land engineering work in the agro-pastoral ecotone? What are the benefits of consolidating the degraded land? This paper aims to introduce the practices of land engineering which have been performed in Yulin City, Shaanxi Province, and to measure the socioeconomic and ecological benefits and the feasibility of using land engineering to transform degraded land in an agro-pastoral zone. The paper also discusses the main modes and positive significances of land engineering to coordinate the human–land relationship and promote rural development in the agro-pastoral zone.

2 Introduction to the Yulin Research Station

The research station for optimization engineering of modern agriculture was established in 2015 and is located in the northern part of Yulin, Shaanxi Province, China. Yulin City is located in the agro-pastoral ecotone of North China (Figure 1). The research station covers an area of 0.8 hectare.

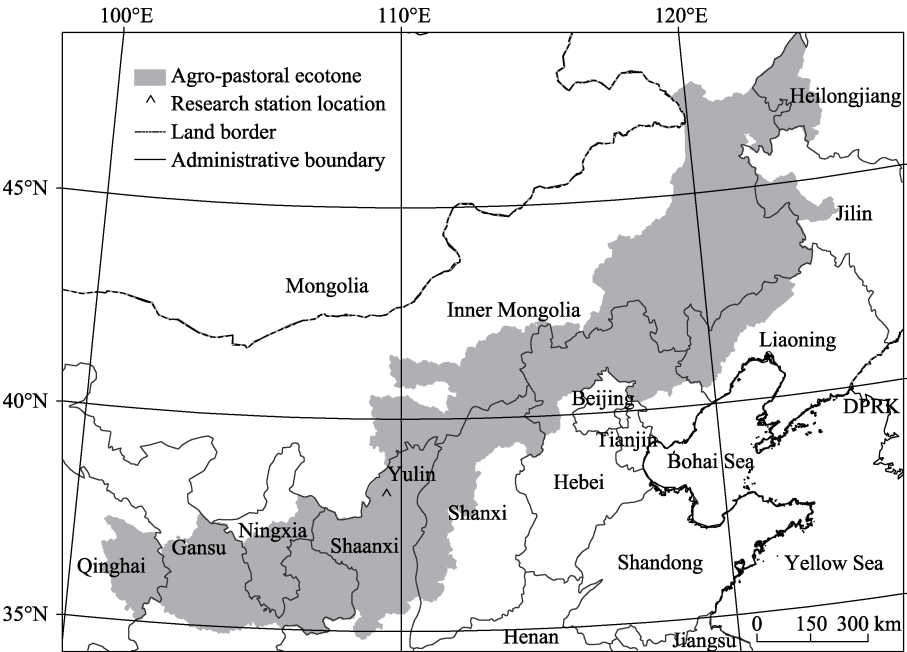


Figure 1 Location of the research station and agro-pastoral ecotones

The location of the station is the Mu Us Sandy Land which has been seriously eroded and degraded by wind and water shortages over the past decades. As a result, grain production in this area is difficult due to the challenging natural conditions. Beside the sandy land, under the Quaternary loess-paleosol sequence of northern China, a layer of red clay was formed in the Late Tertiary, which covers the entire Loess Plateau. The thickness of the red clay is around 50–70 meters (Sun *et al.*, 2001). The parent material of the red clay is the Tertiary red clay. After the loess layer was destroyed by soil erosion, the clay layer became exposed to the surface. Red clay has a sticky texture and poor air permeability. When exposed to the elements, the surface is prone to cracking. The red clay has the same particle size as that of the loess. It has no collapsibility compared with the loess and is the main raw material for making bricks. Loess is a yellow powdery soil with a columnar joint which formed under dry climatic conditions, and collapses within 1 to 2 minutes on water contact (Shi and Shao, 2000). Red clay, loess, and sand continue to be re-distributed in the northern part of Yulin, the material being supplied for the improvement of the sandy land. Given the relatively short distances involved, the transportation costs are low.

Interdisciplinary research on land engineering and modern agriculture generally concerns experiments on soil improvement, crop selection, and field management. In brief, the aims of the studies are to explore differences in soil structure and ploughing improvements, differences in growth and suitability and input-output benefits of land consolidation under different compound types and compound ratios.

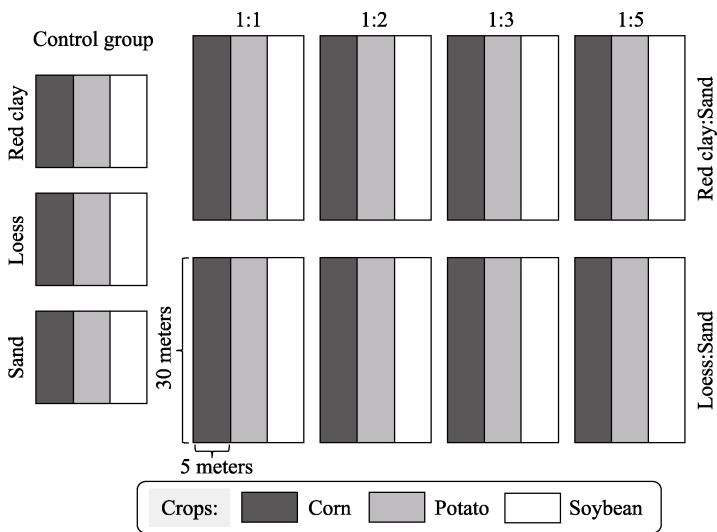


Figure 2 Illustration of experimental cells

2.1 Soil improvement

The soil improvement studied in the experiment includes two aspects. The first is to explore the improvement in crop growth and soil nutrients for different types of land, generally red clay-sand and loess-sand. The composition of the red clay developed in the Tertiary mainly consists of clay, which has water retention and fertilizer retention characteristics, poor air permeability, and easy agglomeration. The loess widely distributed around the research station is mainly composed of silt particles, which are collapsible and prone to soil erosion

(Sun *et al.*, 2013). Sandy land is not suitable for agricultural production given its poor water retention and fertilizer retention qualities. This experiment seeks to exploit the physical complementarity of the soil particle size to mix and recombine with clay, silt, and sand to solve the problems of the sandy land. The second is to explore the improvement of crop growth and soil nutrients in different compounding ratios (e.g., ratios of 1:1, 1:2, 1:3, and 1:5) under the same compound type. Pure red clay, pure loess, and pure sandy land blocks were used as controls.

The thickness of the improved soil, which we prepared as a cultivated layer, was 30 cm. Taking the ratio of 1:1 as an example, the red clay of 25–30 cm thickness was first laid on the bottom layer, with the large red clay block needing to be pulverized to small pieces of 5 cm or less. The original sandy soil with a thickness of 15 cm was then covered on the red clay. Finally, the improved soil mixture needed to be turned over (30 cm deep) to allow the red clay to mix well with the sand.

2.2 Crop selection

Different crops require different growth environments and have different adaptations to the soil, water, nutrients, and management measures. Therefore, how to match a crop's environmental requirements with the improved land's growing environment supply is the key to achieving stable and efficient production in agriculture in consolidated land. In this study, corn, potato, and soybean, which are planted on a large scale in this area, were selected for study. Through observation, monitoring, and comparison, the growth, yield, and economic output of the different crops under different compounding types and compounding ratios were evaluated. Finally, the best soil mix type for different crops could be decided.

2.3 Field management

The annual precipitation in the agro-pastoral ecotone is typically around 400 mm. Water resources are the main factor restricting the land use in the agro-pastoral ecotone. To guarantee the feasibility and scalability of the experiments, it is necessary to explore a set of large-scale planting and management methods after land consolidation. These include fertilization methods, irrigation methods, and monitoring modes. Therefore, at the research station, we use a precise water and fertilizer integrated system to quantitatively control irrigation and fertilization, and carry out water-saving and fertilizer-saving tests according to the crop variety in question. The test results help to promote the practice of land engineering and facilitate sustainable land use and modern agriculture in the agro-pastoral ecotone.

The use of chemical fertilizer (purified amount) per unit area in Yulin has reached 0.20 tons/ha (YBS, 2017). In our experiments, fertilizer was used in a timely manner and properly according to the properties and soil monitoring data to minimize the loss of nutrients. At the same time, organic fertilizer (chicken manure) was substituted for part of the fertilizer to reduce the amount of fertilizer used. In detail, before planting, diammonium phosphate ($(\text{NH}_4)_2\text{HPO}_4$) was applied once, and the amount was 0.050 kg/ha. During the growing period, urea ($\text{CO}(\text{NH}_2)_2$) was applied twice as needed, the amount being 0.015 kg/ha on each occasion. The total amount of chemical fertilizer used was 0.07 tons/ha each year which is far lower than the average amount used in Yulin. In addition, we adopted the precision water

and fertilizer integrated system and drip irrigation facilities to minimize evaporation and waste of water to a certain extent. Compared with ordinary field irrigation, the water saving is over 15%. To avoid mutual interference between adjacent experimental cells, a dedicated water and fertilizer program was implemented for each experimental cell.

3 Evaluation of feasibility and benefits of land engineering

Yulin is a typical city in the agro-pastoral ecotone at the junction of the Loess Plateau and the Mu Us Sandy Land. It is characterized by an ecological fragility, the interlacing of agriculture and animal husbandry, and an uncoordinated relationship between the people and land. Taking 2016 as an example, the total land area of Yulin City was 42,921.1 km², of which the cultivated land area was 10,465 km², the sandy land area was over 14,000 km², the per capita cultivated area was 0.274 ha, and the grain output per unit of cultivated land was 3284 kg/ha. The agricultural output value of the city reached 28.2 billion yuan, and the agricultural output value per unit of cultivated land area was 26,946 yuan/ha. In sum, Yulin has a large scale of agricultural production and cultivated land. However, Yulin currently has problems relating to poor quality of cultivated land, low agricultural output value, and a relatively low income for the workers (Figure 3).

In terms of industrial structure, from 2000 to 2015, the proportion of primary, secondary, and tertiary industries in Yulin changed from 13.3/44.4/42.3 to 5.8/61.1/33.1, respectively (Figure 4). The primary industry mainly refers to agriculture, the secondary industry mainly includes industry and construction, and the tertiary industry includes other industries, including transportation and service industries. The proportion of employees in the three types of industries changed from 63.0/11.8/25.2 in 2000 to 47.4/28.4/24.2 in 2015 (Figure 5). Although the output value of the primary industry in Yulin is not high, the number of employees in this sector is still the highest. As of 2015, more than 50% of rural workers are mainly engaged in agricultural production (Figure 6), and agriculture is still the key to local rural development.

Along with an increase in the proportion of rural non-agricultural employment, the proportion of rural arable land that has been left idle has increased. In the period 2011–2015,

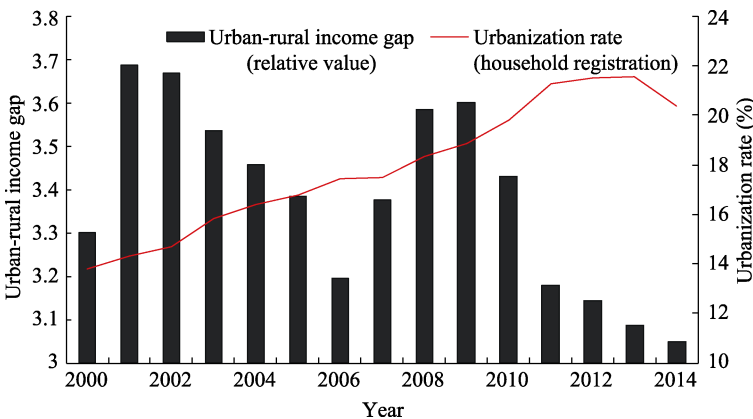


Figure 3 Urban and rural income gap in Yulin City

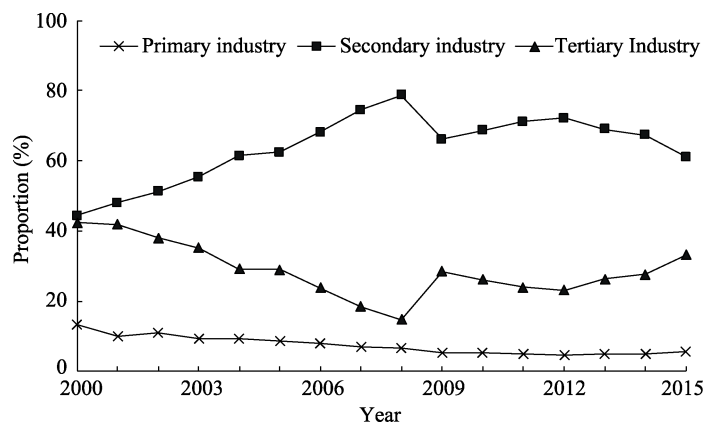


Figure 4 Evolution of industrial structure in Yulin City, 2000–2015

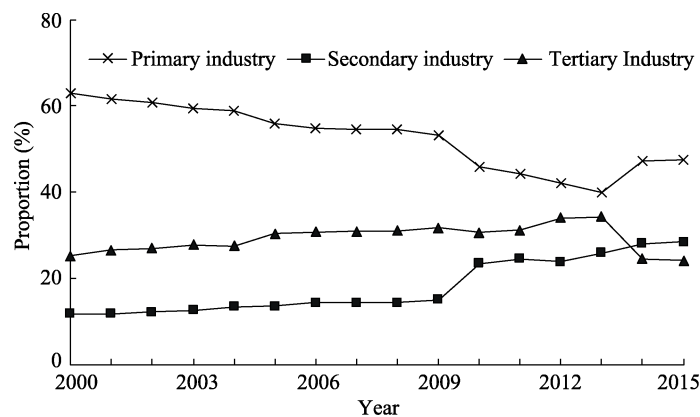


Figure 5 Evolution of employees in the three types of industries in Yulin City, 2000–2015

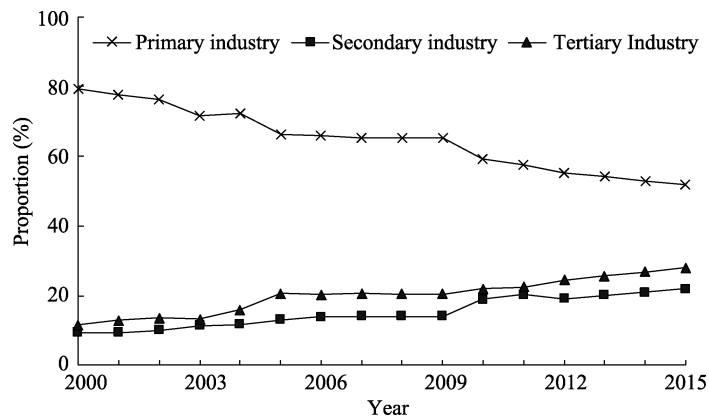


Figure 6 Evolution of employees in the three industries in terms of rural labor in Yulin City, 2000–2015

the proportion of rural non-agricultural employment in Yulin increased from 42.64% to 48.24% while the multiple-crop index decreased from 98.04% to 73.79%. The traditional extensive agricultural management has caused serious problems of resources waste and low

efficiency in local agriculture. Therefore, by using engineering techniques to improve the quality of cultivated land, and applying modern agricultural management techniques to improve the scale benefits of cultivated land and to increase the efficiency of agricultural output, new direction for Yulin's agricultural development is engineering in the coming years.

3.1 Crop yields and economic benefits

Through the field planting experiments, stable crop yields were obtained after the two-year study as shown in Table 1.

Table 1 Comparison of crop yields and economic benefits between normal conditions and the present study for Yulin City in 2017

Crop types	Planting area	Yield (ton/ha)	Unit price (yuan/kg)	Gross income (yuan/ha)
Corn	Experiment	12.00–14.25	1.40	16800–19950
	Normal	11.25		15750
Potato	Experiment	25.50–42.00	1.40–1.60	35700–67200
	Normal	36.00		50400–57600
Soybean	Experiment	3.60–4.50	4.00	14400–18000
	Normal	3.00–4.50		12000–18000

The results show that, under the appropriate management and protection modes, the highest yields for the experimental crops can reach or exceed the regional average yield, and the corn yield under the optimal compounding ratio exceeds the normal farmer's planting yield by more than 25%. In the study, potato has the highest gross income, which can reach 67,200 yuan/ha, while soybean and corn have a lower gross income, less than 15,000 yuan/ha after deducting costs. It should be noted that planting potatoes requires management that is more elaborate and higher costs for water and fertilizer, and has continuous cropping barriers, while corn and soybean have lower management and water costs and require lower levels of technology. Considering the labor and mechanical costs for sowing potatoes, management, and harvesting, the cost of cultivating potatoes is about 12,000 yuan/ha higher than that of corn according to the rural labor compensation level in Yulin. There is also a need to consider raw materials, transportation, manpower, and machinery costs for soil improvement, land consolidation costs for the different compound types, and the fact that the compounding ratios are different. The higher the proportion of soil that is compounded, the higher the costs (Table 2).

The raw materials used at the research station are red clay and loess taken from the local area of Yulin City, which has low transportation costs and is readily available. The undulating nature of the terrain of the original land, however, makes it less conducive for consolidation. Hence, use of a tractor to level the land is the first step in land consolidation. Field leveling costs include the rent for agricultural machinery and labor costs. After field leveling, given that the newly consolidated land is barren and lacks nutrients, it is necessary to apply a certain amount of base fertilizer. In this case, we use urea (organic fertilizer) and diammonium phosphate (chemical fertilizer) as the base fertilizer. Plowing costs include the rent for agricultural machinery and labor, and it is a crucial to ensure that the new soil is soft enough

to grow crops. The costs in this table are based on the local conditions existing in Yulin, but may vary from region to region.

In terms of cost, the higher the compounding ratio, the higher the cost of land improvement. The cost of using red clay to improve sandy land at the same compounding ratio is higher than that of using loess in Yulin. Taking into account the cost of land consolidation and the cost of land transfer, the improved land can offset the cost of remediation in 3–5 years’ time and approach sustainable agricultural output.

Table 2 Land consolidation costs for the study (for prices at 2014)

Compound types and ratios		Raw material (yuan/ha)	Field leveling (yuan/ha)	Base fertilizer (yuan/ha)	Plow (yuan/ha)	Total (yuan/ha)
Red clay and sand	1:1	90000	3000	3000	1200	97200
	1:2	75000	3000	3000	1200	83200
	1:3	67500	3000	3000	1200	74700
	1:5	60000	3000	3000	1200	67200
Loess and sand	1:1	60000	3000	3000	1200	67200
	1:2	50000	3000	3000	1200	57200
	1:3	45000	3000	3000	1200	52200
	1:5	40000	3000	3000	1200	47200

3.2 Analysis of social and ecological benefits

By way of land consolidation, land productivity improves and generates social and ecological benefits. In Yulin, the exposed sandy land area was 1.41 million ha in 2016 (YBS, 2017). If we develop and transform 30% of this land into cultivated land via land engineering techniques, then in about 3–5 years’ time, the per capita cultivated land in Yulin (calculated via the resident population) will reach 0.383 ha and will increase 39.90% compared with that in 2016. In this way, the problem of desertification will be controlled and local ecological security may be guaranteed. According to the existing agricultural income structure, the per capita rural households’ net income will increase by more than 1100 yuan and this statistic is confirmed by the experiments. Moreover, according to the policy of requisition–compensation balance for cultivated land, the cultivated land after land consolidation provides a reserve security and development space for urban construction, which is conducive to the further advancement of local new urbanization. At present, the “Three Changes” reform is generally promoted nationwide in China. “Three Changes” indicates that resources become assets, funds become stocks, and farmers become shareholders. In Yulin City, its land resource endowment is poor while the asset value of resources is limited. However, by exercising the engineering and technical means of land consolidation, the unused and degraded land is transformed into cultivated land, and the middle- and low-yield fields are transformed into high-yield fields. This will increase high-quality land resources, facilitate the implementation of the “Three Changes” reform, increase farmers’ income and promote rural development.

Zhaojiamao is a small village located about 20 km southeast of Yulin City. The land resources there are relatively barren. The total number of people is 630 and the land area is 7.8

km². In 2012, the per capita net income for each household in the village was only 6650 yuan, of which 80% was due to the undertaking of non-agricultural work outside of the village. Owing to its poor local economy and shortage of employment opportunities, the young laborers of Zhaojiamao decided to vacate their houses, effectively leaving them abandoned. Since 2013, taking the “Three Changes” reform as an opportunity, Zhaojiamao has used land engineering methods to consolidate its land and upgrade its village. As a result, land productivity was improved and land use efficiency increased. By 2016, the per capita net income of Zhaojiamao reached 11,200 yuan.

Chaheze is a village located 36 kilometers northwest of Yulin City. It is a typical village in Yulin’s windy sand and grassland area. Because of the poor land resources, local crop yields are low and unreliable. The local people chose mainly to abandon their uncultivated land and went elsewhere to work. Since 2012, land consolidation has been carried out by an agricultural company, and huge changes have occurred. The average yield of corn reached 13.5 tons/ha, which increased the yield by 3 tons/ha compared with the past. The high-quality land was packaged and transferred to the company through the village collective. As a result, the village gets an annual income of 400,000 yuan, and each villager gets a land transfer fee of more than 2300 yuan. During the harvest seasons, the company hires the local workers and each one can earn more than 100 yuan a day (in 2015). In contrast, the workers’ annual income from agriculture was less than 1000 yuan per mu (15 mu equals a hectare) in the past. Land consolidation has completely changed the resource situation of the village and the human–land relationship has become coordinated. The local people benefit from large-scale land cultivation after land consolidation.

China’s desertified land, which covers an area of 1.72×10^6 km², is mainly distributed in the agro-pastoral ecotone in the north and the northwest arid zone (Wu and Ci, 2002). Desertification still presents a challenge to agriculture and the ecological conditions in China’s agro-pastoral ecotone. Studies have shown that desertification is caused by both natural factors and the extensive use of artificial land. The essence of this is that too rapid a growth in population can exceed the ecological capacity and recovery, leading to an imbalance between humans and land (Wang *et al.*, 2013). After remediation of degraded desert land via land engineering, the exposed surface of sandy land can be effectively reduced. More importantly, due to the characteristics of sandy land, which can be concentrated and distributed over a large scale, the new cultivated land patterns after development and improvement will be different from the existing fragmented cultivated land patterns. Concentrated cultivated land is more conducive to large-scale management and mechanized production, and may fundamentally alleviate the problem of land degradation in the agro-pastoral ecotone.

4 Conclusions and discussion

4.1 Conclusions

A research station was established in Yulin to study the impact of land engineering in the agro-pastoral zone on local agriculture and rural development. The studies performed concerned mainly soil improvement, crop selection, and field management, and results verify the feasibility of applying land engineering in the agro-pastoral zone. A theory-experiment-application-promotion system was explored through these three investiga-

tions and the outputs provided technical support for agriculture and rural development in the agro-pastoral zone.

Although the proportion of agricultural output in terms of GDP is declining year by year, agriculture is still an important industry for Yulin, especially for local rural areas. The proportion of Yulin's primary industrial production in 2015 was 5.77%, but the proportion of rural laborers engaged in agricultural work was more than half the population, accounting for 51.76%. The quality of cultivated land in Yulin is limited, which partly leads to inefficient agricultural production and the low-income for farmers. The significant income gap between urban and rural areas shows the uncoordinated relationship between people and the land. In 2015, Yulin's crop yield was 2962 kg/ha, only 49.50% of the national average and 67.53% of the average for Shaanxi Province, and the rural per capita net income was 10,636 yuan, only 33.16% of the urban per capita net income.

The experimental results show that land engineering can effectively enhance cultivated land quality and output efficiency, and improve the economic benefits by having cultivated land. Through the implementation of land engineering, the yields of corn, soybeans and potatoes reached 14.25, 4.50 and 42.00 tons per ha under the optimal ratio. The yield of corn and potatoes increased by 26.67% and 16.67% compared with the local average. Soybeans yield was similar to the local average value. Taking into account the cost of land engineering, the cost of land transfer and the local price levels, the costs derived as a result of land improvements match the input costs for land consolidation within 3–5 years.

In addition to improving agricultural production conditions, land engineering also brings about social and ecological benefits. It is also an important means to promote rural development and achieve rural revitalization. Through land engineering, the villages of Zhaojiamao and Chaheze have seen the quality and scale of land enhanced by soil improvement, reclamation, and land transfer. The per capita income has increased by more than 8000 yuan in Zhaojiamao Village and 2000 yuan in Chaheze Village.

4.2 Discussion

Yulin has a large amount of land resources but the agricultural production efficiency has been a challenge due to the land degradation. Given that more than 50% of rural laborers in Yulin are engaged in agricultural work, agriculture still plays an important role in rural households' income. Thus, it is necessary to exploit and consolidate unused and barren land to improve agricultural production efficiency. The studies at Yulin research station have demonstrated that by mixing and incorporating red clay and loess with sandy land we can turn the sandy land into cultivated land. In this way, land engineering has increased land use efficiency and transformed degraded land in the agro-pastoral ecotone. This activity also helps to coordinate the human–land relationship in rural Yulin.

Through field visits and experiments in Yulin, it has been found that taking land consolidation as the core, there are two ways to achieve regional agriculture and rural development, and ultimately human–land coordination. The first way is the Zhaojiamao model mentioned above. With land engineering technology as the basis for support, the integration of various types of empty and inefficiently used land in the village will be realized, such that the quantity and quality of land resources will be improved. Through the “Three Changes” reform, the capitalization of the village resources will be realized, and the endogenous driving force

for the development of the village will be enhanced. This path is applicable to rural areas with certain features. By optimizing and allocating land resources, the resources of the village are integrated, and the industry is upgraded, while the regional characteristics of the village are preserved. This is a way that uses land consolidation to activate rural resources to achieve rural development and revitalization from within (Liu and Li, 2017a).

The second way is by creating modern agricultural parks, like the Chaheze model mentioned above. Also supported by land engineering technology, the large-scale wasteland, sandy land, and low-quality cultivated land will be improved, and finally a high-standard modern agricultural park will be built, operated by enterprises or qualified organizations. Local farmers can obtain rent or dividends through land transfer, meanwhile they can secure jobs in the park. This pattern is suitable for rural areas where land degradation and population loss are serious. It is conducive to standardization and modern management of agricultural production, thus improving the scale efficiency of agricultural production. This way could alleviate pressures on food security in the central region and respond to the “second granary” policy.

Regarding the local food security, the primary task of consolidating degraded land in the agro-pastoral ecotone is to exploit the potential of local land resources, improve the land carrying capacity, and coordinate the human–land relationship on the premise of ensuring ecological security. On this basis, the efficient use of land resources can be realized through proper resource allocation and management. In this process, characteristic agriculture or large-scale agriculture can be developed according to local conditions and this agricultural pattern helps to revitalize the local rural economy.

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